OBSERVATIONS ON SOME LARVAL AND POST-LARVAL STOMATOPODS*

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(*With two plates*)

Synopsis

1. Habits of larval and post-larval stomatopods of the genera *Squilla* and *Lysiosquilla* were studied by observation on specimens kept in aquaria.

2. The peculiar reactions of the pelagic larvae to light are detailed.

3. The characteristic feeding habits of the larvae and adults are described.

4. Pronounced cannibalistic tendencies are noted in the group.

5. The mechanism of larval and post-larval moults is described and discussed.

6. Eye stalks, as in other crustacea, appear to control the development of chromatophores. Removal of eye stalks does not affect moulting, growth and metamorphosis.

7. Removal of eye stalks a few days prior to final larval moult results in the production of blind albino specimens of post-larvae. The rudiments of post-larval pigments are well laid in the advanced pelagic larva.

Introduction

Though Stomatopods are quite abundant in the tropics they are generally considered useless as food except in certain places in the Far East where, like prawns, they form an article of human diet. Living usually in burrows and crevices, they are seldom caught in a state in which they can thrive in aquaria and therefore, very little is known about their life habits. Recently Bigelow (1941) has given an account of the habits of *Squilla empusa* Say after his observations on live specimens in an aquarium at Woods Hole.

The observations detailed in the present paper were made when the author was working on the stomatopod larvae of the Madras plankton, at the University Zoological Research Laboratory, Madras[1].

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[1] The paper was written when the author was working at the Fresh-water Biological Research Station, Madras, but was revised and finalised for publication after his transfer to the Central Inland Fisheries Research Station, Barrackpore.

Since specimens of post-larval stomatopods were then being reared in the aquarium tanks, the author had ample opportunities to observe these animals alive at close quarters and study their habits. The author is indebted to Prof. R. Gopala Aiyar, the then Director of the laboratory and also to the University of Madras for the facilities he was given to carry out the work. His thanks are also due to Dr. B. N. Chopra for kindly going through the manuscript and offering valuable suggestions.

Feeding Habits of Larvae

It has been shown that the late planktonic larvae could be made to metamorphose into the post-larvae in the laboratory and that the post-larval forms so obtained could, with proper care, be grown in aquarium tanks to a fairly large size (Alikunhi and Aiyar, 1942; 1943; Alikunhi, 1944, a, b). The larvae which generally keep healthy in the aquaria are transparent. The feeding habits of these larvae are peculiar. When minute bits of flesh of *Emerita* are introduced into the aquarium the larvae quickly sense the presence of food, show great activity, get hold of the bits by the help of their raptorial claws, hold them firmly at the mouth by means of the maxillipeds and begin to feed while actively swimming. The larvae being transparent, it is interesting that at a casual glance the particles of food appear as moving about apparently by themselves.

In the aquarium, the larva generally swims near the surface but it also frequents the bottom layers. It therefore picks up the particles of food even from the bottom of the aquarium.

Reaction to Light

The larvae generally show certain definite reactions to light. When placed in a glass trough of sea water and when the maximum incidence of light is on one side of the trough, the larvae are invariably found to crowd on the opposite side of the vessel where there is less light. When the light is obstructed by a piece of paper or even with the palm of the hand, the larvae react almost instantaneously and begin to swim about in the vessel normally in all directions. When the obstruction is removed and the light again allowed to fall fully on the side of the vessel the larvae promptly swim away and crowd on the opposite side as before. While keeping the larvae in the aquaria, therefore, a sheet of brown paper was wrapped on that side of the trough which had the maximum incidence of light so that uniform lighting was ensured in the container and the larvae behaved normally.

Moulting

It is interesting to note that till now the final pelagic larvae of only a few species of stomatopods (*Squilla empusa, S. quadridens, Lysiosquilla excavatrix* and *L. eusebia*) have been observed to moult into the post-larvae. But even in these species the actual process of transformation into the post-larva has not been described in detail.

Faxon (1882) has seen a larva of *S. empusa,* 17 mm. long, metamorphose into a post-larva, 19 mm. in length. Bigelow (1894) dealing with *S. quadridens,* mentions that 'in the passage from the larval to the adult form the body becomes broader and more compact at the expense of its length, so that shortly after the moult it is but 1.1 cm. in length, while before it was 0.5 cm. longer'. Giesbrecht (1910) observes that the final pelagic larva of *S. mantis* and *S. desmaresti* measures 20-22.5 and 21-22.5 mm. respectively, while the first post-larval stage measures 17-18 and 16 mm. respectively. My own observations also go to show that there is a definite reduction in length following the final larval moult, particularly in the larvae of the *S. nepa* and *S. quinquidentata* groups in which the pre-labial region is highly telescoped. Instances, however, are not wanting where the reduction in length is rather insignificant as in the short, stout larvae of the small-eyed species of the 'Chloridella' group. As noted by Bigelow, generally, during transformation from the larval to the post-larval stage the body becomes broader and stouter at the expense of its length.

All the species of stomatopod larvae commonly occurring in the Madras plankton have been correlated with their adults by rearing the planktonic larvae and metamorphosing them into the post-larvae in the laboratory (Alikunhi—unpublished). Observations on larval and post-larval moults could, therefore, be made on 12 species of the genus *Squilla* including the common forms *S. nepa, S. holoschista, S. wood-masoni* and *S. raphidea,* and on three species of the genus *Lysiosquilla* namely *L. maculata, L. tigrina* and *L. multifaciata.*

Time of Final Larval Moult.

Larvae which are in the final pelagic stage could be recognized under the binoculars by the outline of the post-larval carapace and telson that is clearly visible through the transparent larval exoskeleton. This outline of the post-larval body appears only in the final pelagic stage. Such larvae, if kept in fresh sea water aquaria, are invariably found to metamorphose into post-larvae during the night. It is remarkable that the frail, transparent pelagic larva transforms itself into a totally different post-larva overnight, in the course of 6 to 10 hours after definition of the post-larval body outline.

To ascertain whether darkness had any particular effect in hastening the final larval moult and metamorphosis, 18 specimens of the final pelagic larvae of *S. nepa* were placed in the morning in an earthenware vessel containing fresh sea water and the vessel was kept covered to avoid all light. Examination at 1 p.m. and at 4 p.m. showed that the larvae remained unchanged. By next morning however, 15 of the larvae had metamorphosed. Similar larvae, from the same collection kept in a glass trough of sea water, also metamorphosed overnight, and the early post-larvae in both the cases were identical in the intensity of pigmentation, etc., showing that both the groups had metamorphosed almost at the same time. On other occasions also, larvae picked out from the tow-net collections in the morning and kept in glass aquaria, metamorphosed into post-larvae only during the night. It might, therefore, be inferred that in the

open sea also the final moult and metamorphosis normally take place at night, though darkness by itself does not appear to have any particular effect in hastening metamorphosis.

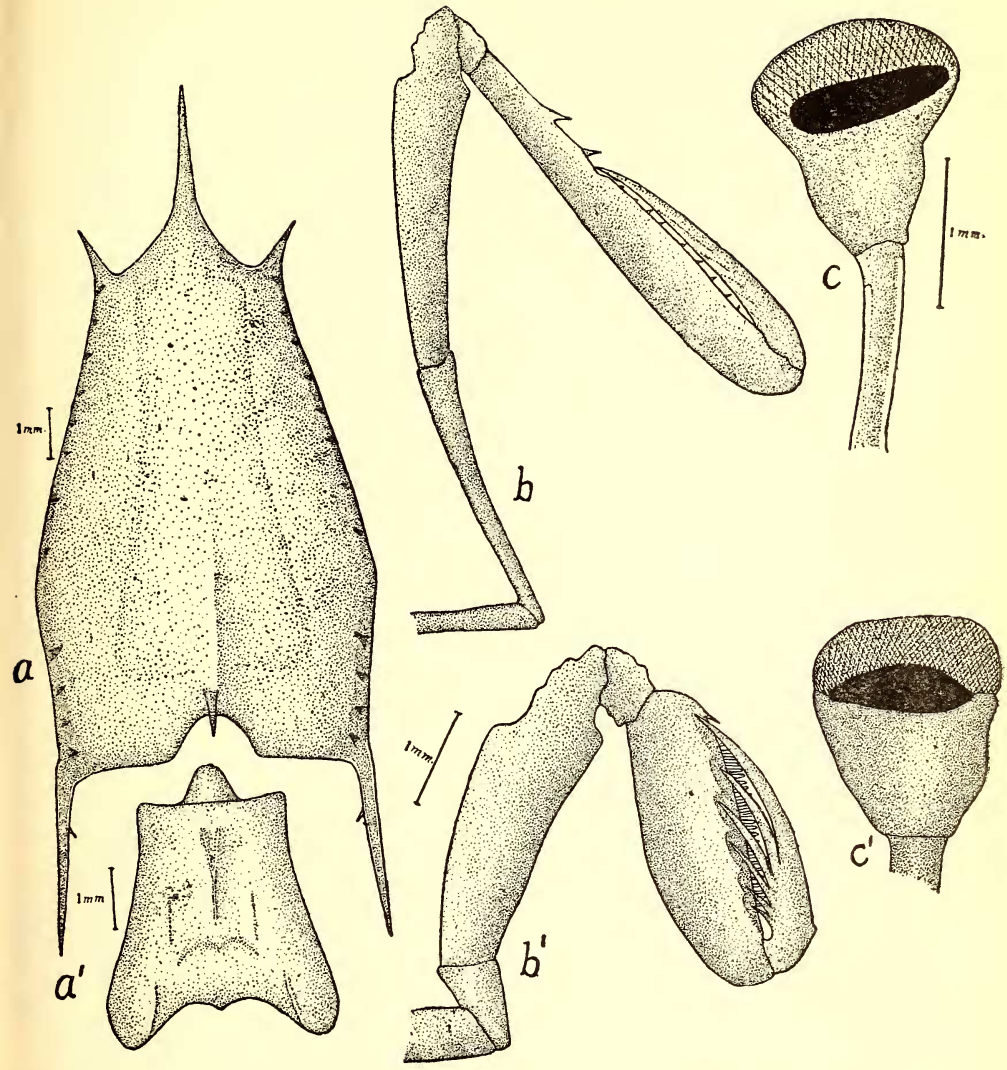
In the laboratory the final larval moult invariably took place after 10 o'clock in the night. Unfortunately, the actual process of moulting could not be observed in detail, but the complete moults and a series of specimens in the different stages of moulting have been collected so as to furnish a full account of the process.

Final Larval Moult and Metamorphosis.

The following observations were made on larvae of *S. nepa* but the statements are equally applicable to other species of stomatopods occurring on the Madras coast.

It is interesting to note that while the general broadening of the post-larval body is effected at the expense of its length, in the case of the carapace, only a narrow median strip of the larval structure takes part in the transformation into the post-larval carapace (Plate 1, a-a'). This median strip is clearly indicated in the final pelagic larva, but is more than double the length of the post-larval carapace. During moulting the larval carapace, together with the peripheral skin falls off, exposing the median soft skin which soon gets hardened. It is thrown into a series of folds anteriorly, thereby getting shortened. With the quick hardening of the new carapace the folds also disappear and finally the general shape of the adult carapace is assumed. While these changes are taking place, the terga of the last three thoracic segments split longitudinally in the middle and through the opening so formed the soft post-larval body which by then is free from its larval coat, is gradually drawn out by a series of convulsive movements of the abdominal segments. Quickly following this the anterior limbs are also pulled out of their larval covering. On completion of this casting off of the larval skin, the post-larval body, being very soft, quickly undergoes some shortening. The region between the antennae and the labium and the last three thoracic segments get considerably shortened and assume proportions totally different from those in the larva. With the hardening of the new skin, the various organs show a closer approximation to the adult condition than in the previous larval stage. During this quick process of transformation the following changes, besides the general broadening of the body and the formation of the new carapace, are conspicuous: The eye stalks become short and stout, with the cornea set more in the fashion characteristic of the adult (Plate 1 c-c'). The raptorial dactylus becomes provided with a series of well-developed free spines which were just visible through the transparent skin of the pelagic larva (Plate 1 b-b'). The last three thoracic segments get conspicuously broadened and their lateral sides are provided with characteristic processes (Plate II a-a'). The pleopods which in the larva had the gills in the form of compact bundles, now have them branched and finely plumose (Plate II b-b'). The telson and the uropods largely approximate to the adult condition (Plate II c-c').

The frail body of the pelagic larva is singularly transparent and generally devoid of pigment. The early post-larva has the body



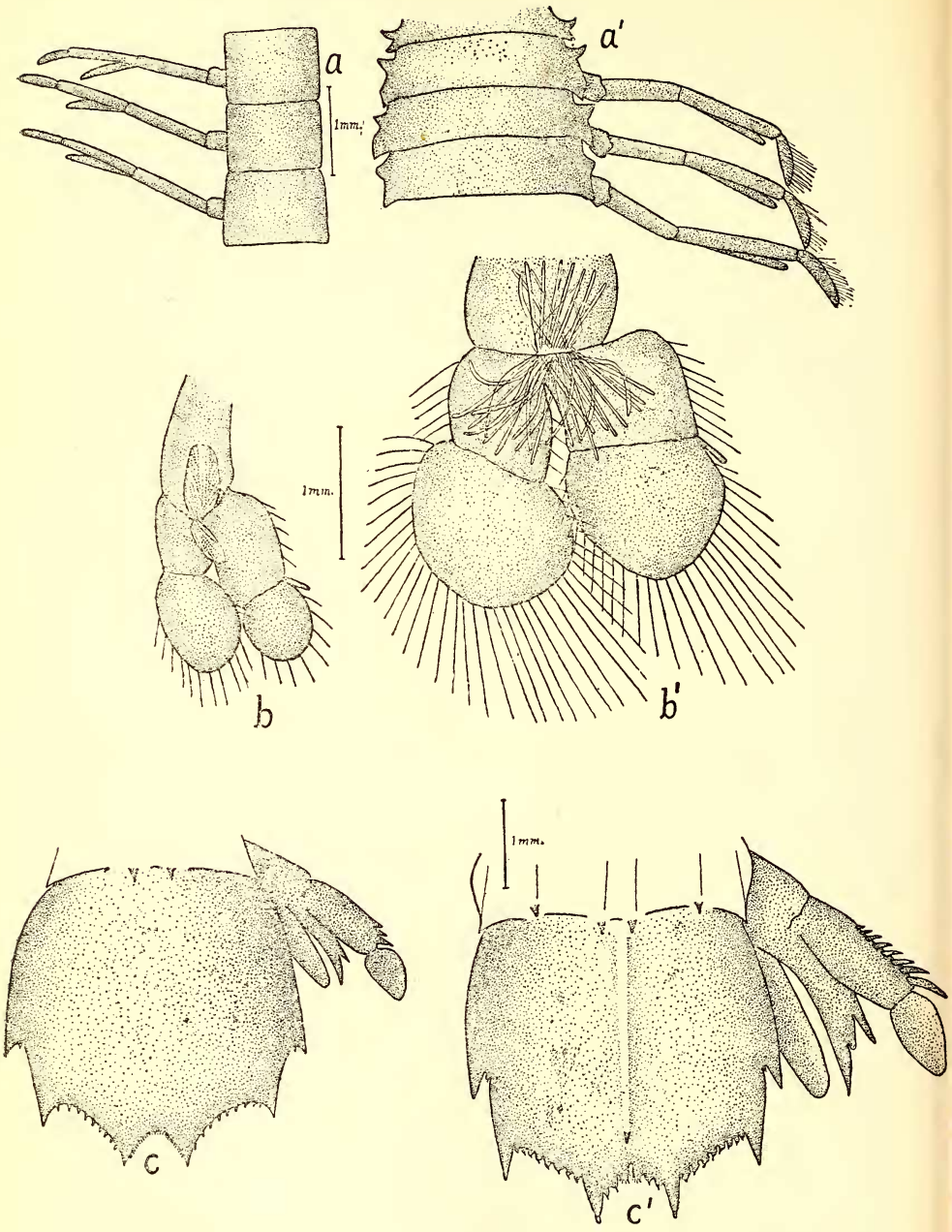
Squilla nepa

Modification of structures during metamorphosis from pelagic larva to post-larva

a. Carapace of final pelagic larva ; a′. Same of early post-larva.

b. Raptorial claw of final pelagic larva ; b′. Same of early post-larva

c. Eye of final pelagic larva ; c′. Same of early post-larva.



Squilla nepa

Modification of structures during metamorphosis from pelagic larva to post-larva

a. Last three thoracic segments of final pelagic larva ; a'. Same of early post-larva.
b. Pleopod of final pelagic larva ; b'. Same of early post-larva.
c. Telson and uropod of final pelagic larva ; c'. Same of early post-larva.

opaque and several chromatophores are now distributed all over the dorsal body surface, often forming definite patterns. With metamorphosis the pelagic existence is also abandoned and the post-larva confines itself to the bottom of the aquarium.

It is of interest to note that while most of the changes undergone during the final larval moult are already heralded by the more or less distinct outlines of post-larval structures in the late pelagic larva, the very conspicuous transformation from the larval to the post-larval body is remarkable in that it is achieved in the course of a relatively short period of 6 to 10 hours.

Post-Larval Moult.

Post-larval specimens kept in the aquarium and regularly fed, undergo the first moult within $4\frac{1}{2}$ to 6 days after metamorphosis. Unlike the final larval moult, the post-larvae moult during any time of the day or night. It may be mentioned that early *Alima* larvae also when kept in aquaria, moult into later stages during day time.

The post-larva when about to moult, becomes less active and repairs to a quiet corner of the aquarium. The body then appears less bright than before. The process of moulting is essentially the same as in the pelagic larvae. The terga of the last three thoracic segments split longitudinally in the middle, the abdominal portion is first drawn out of the old coat through the opening so created, the carapace comes off and falls away or sometimes may remain connected with the rest of the moult by the anterior end, and finally the cephalic and thoracic appendages are also freed from their old covering. Occasionally when the abdominal moult is completed, the specimen begins to swim in an excited fashion (with the slough trailing) trying to get the anterior limbs also free. It soon falls to the bottom as if exhausted.

Immediately after moulting since the chitinous covering has not hardened, the specimen is rather weak and unable to move about actively. It often swims by an awkwardly synchronised movement of the limbs and then more or less passively falls to the bottom. During this period it is completely helpless and highly vulnerable to attacks by enemies. Cannibalism is rather pronounced in the group and if more than one specimen are kept in an aquarium and if any of them undergoes a moult, it usually falls an easy victim to the predatory leanings of its brethren. This destructive tendency is manifested also when specimens of different sizes are kept together in an aquarium, the smaller ones being preyed upon by the larger.

The mechanism and periodicity of larval and post-larval moults are similar in the genus *Lysiosquilla* also.

Feeding Habits of Post-Larvae and Adults

The early post-larvae continue to live and grow in the aquaria provided the water is daily changed and they are regularly fed with suitable food. In the present series of experiments, the mole crab *Emerita asiatica* which occurs in large numbers in the inter-tidal zone of the Madras beach, was found to be quite an agreeable food